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## **Variable Resolution Scanning**

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## VARIABLE RESOLUTION SCANNING

### TECHNICAL FIELD

This invention relates to image scanning and, in particular, to determining an optimal scanning resolution.

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### BACKGROUND

Scanning technology captures an image, or regions of an image, from a printed document, photograph, or other similar image media, and converts the image into an electronic form. Initially, an image is scanned to generate a 10 preview of the image, which is also commonly referred to as a preview scan. To save file space in memory, only those sections of the image that are intended to be used can be selected from the preview scan before performing a final scan of the image and generating image data that will be saved in memory.

15 An image media, such as a document, can have any number of image regions that are commonly designated as text, tables, photographs in either black and white or color, and line art or graphics in either black and white or color. Typically, a scanning software application receives scanned image data and classifies the different image types into image regions for a particular 20 document.

A preview scan is typically a low resolution scan of an image which takes less time to process, but is displayable for user processing. For example, regions of an image shown in a preview scan can be selected, or otherwise cropped, from which a final scan of the selected image regions is generated.

25 For the second, and final scan, a flatbed scanner re-scans only the selected

image regions at a higher resolution to produce a higher quality printable and viewable scanned image.

A common resolution pixel per inch (PPI) value for an initial preview-scan is 75 ppi which takes less time to generate the image data than it would for 5 a higher resolution scan. For a final image scan, such as for photos and graphics, a higher resolution of 150 ppi is considered optimal, and for text that will be processed for optical character recognition (OCR), 300 ppi is considered to be optimal. These PPI values are described as "optimal" with respect to the resolution detection capability of the human eye. For the most 10 part, a human eye cannot detect a difference between 150 ppi and three-hundred 300 ppi.

A user can typically set, or select, the resolution for a final scan of an image. High resolutions, such as 600 ppi, are only needed for photo enlargement and similar specialty applications. Most applications do not 15 require image data to be scanned at higher than 300 ppi. However, conventional scanning software applications allow a user to set the scan resolution from anywhere between 12 ppi and 9,600 ppi. Novice users select high scan resolution values without realizing that scanning an image for a resolution of 9,600 ppi would create a very large image data file, and take an 20 extensive amount of time to process, yet not provide any better detectable resolution than 150 or 300 ppi for a common-use scanning application.

## SUMMARY

An imaging system includes a destination selection control to select a 25 destination for scan data generated from an image. A software or firmware component determines a scan resolution for the scan data corresponding to a data type associated with the selected destination, and an imaging device, such

as an automatic document feed scanning device, or an imaging unit in an imaging device, generates the scan data with the scan resolution. The software or firmware component determines the scan resolution corresponding to an image data type, or to a text data type.

5        The imaging system can also include a resolution selection control to select a destination resolution. The software or firmware component determines a scan resolution that is different than the destination resolution, and generates the scan data with the different scan resolution. The software or firmware component determines the scan resolution less than the destination  
10      resolution, greater than the destination resolution, or determines the scan resolution based on a variable resolution mapping.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

15      The same numbers are used throughout the drawings to reference like features and components.

Fig. 1 is block diagram that illustrates various components of an exemplary multifunction device.

Fig. 2 is block diagram that illustrates various components of an exemplary computing device.

20      Fig. 3 is a block diagram that illustrates components of an exemplary image scanning system.

Fig. 4 is an illustration of an image scanning system user interface.

Fig. 5 is a flow diagram that describes a method for variable resolution scanning.

25      Fig. 6 is a flow diagram that describes a method for variable resolution scanning.

## DETAILED DESCRIPTION

### Introduction

The following describes systems and methods for variable resolution scanning. An imaging system determines the best scan resolution for scanning an image based on either a destination data type for the scanned image, or on a user selected scan resolution value. The imaging system determines the best scan resolution for a user selected scan resolution value based on variable resolution mapping that considers both processing time and resolution quality when scanning the image.

### 10 Exemplary Multifunction Device Architecture

Fig. 1 illustrates various components of an exemplary multifunction device 100. A multifunction device, as the name implies, is a device capable of multiple functions which are related, but not limited to, printing, copying, scanning, to include image acquisition and text recognition, sending and receiving faxes, print media handling, and/or data communication, either by print media or e-media, such as via email or electronic fax.

Multifunction device 100 includes one or more processors 102, an electrically erasable programmable read-only memory (EEPROM) 104, ROM 106 (non-erasable), and a random access memory (RAM) 108. Although multifunction device 100 is illustrated having an EEPROM 104 and ROM 106, a particular device may only include one of the memory components. Additionally, although not shown, a system bus typically connects the various components within multifunction device 100.

Multifunction device 100 also includes a firmware component 110 that is implemented as a permanent memory module stored on ROM 106. Firmware 110 is programmed and tested like software, and is distributed with the multifunction device 100. Firmware 110 can be implemented to coordinate

operations of the hardware within multifunction device 100 and contains programming constructs used to perform such operations.

Processor(s) 102 process various instructions to control the operation of multifunction device 100 and to communicate with other electronic and computing devices. The memory components, EEPROM 104, ROM 106, and RAM 108, store various information and/or data such as configuration information, fonts, templates, print data, scanned image data, and menu structure information. Although not shown, a particular multifunction device can also include a flash memory device in place of or in addition to EEPROM 104 and ROM 106.

Multifunction device 100 also includes a disk drive 112, a network interface 114, and a serial and/or parallel interface 116. Disk drive 112 provides additional storage for data being printed, copied, scanned, and/or faxed, or other information maintained by multifunction device 100. Although multifunction device 100 is illustrated having both RAM 108 and a disk drive 112, a particular multifunction device may include either RAM 108 or disk drive 112, depending on the storage needs of the multifunction device.

Network interface 114 provides a connection between multifunction device 100 and a data communication network. Network interface 114 allows devices coupled to a common data communication network to send print jobs, faxes, menu data, and other information to multifunction device 100 via the network. Similarly, the serial and/or parallel interface 116 provides a data communication path directly between multifunction device 100 and another electronic or computing device. Although multifunction device 100 is illustrated having a network interface 114 and serial and /or parallel interface 116, a particular multifunction device may only include one such interface component.

Multifunction device 100 also has a print unit 118 that includes mechanisms arranged to selectively apply ink (e.g., liquid ink, toner, etc.) to a print media such as paper, plastic, fabric, and the like in accordance with print data corresponding to a print job. For example, print unit 118 can include a 5 conventional laser printing mechanism that selectively causes toner to be applied to an intermediate surface of a drum or belt. The intermediate surface can then be brought within close proximity of a print media in a manner that causes the toner to be transferred to the print media in a controlled fashion. The toner on the print media can then be more permanently fixed to the print 10 media, for example, by selectively applying thermal energy to the toner.

Print unit 118 can also be configured to support duplex printing, for example, by selectively flipping or turning the print media as required to print on both sides. Those skilled in the art will recognize that there are many different types of print units available, and that for the purposes of the present 15 invention, print unit 118 can include any of these different types.

Multifunction device 100 also has a scanning unit 120 that can be implemented as an optical scanner to produce machine-readable image data signals that are representative of a scanned image, such as a photograph or a page of printed text. The image data signals produced by scanning unit 120 20 can be used to reproduce the scanned image on a display device, such as a computer display or a printer.

Multifunction device 100 also includes a control panel and menu browser 122, and a display panel 124. The control panel and menu browser 122 allows a user of the multifunction device 100 to navigate the device's 25 menu structure. Control panel 122 can be indicators or a series of buttons, switches, or other selectable controls that are manipulated by a user of the multifunction device. Display panel 124 is a graphical display that provides

information regarding the status of the multifunction device 100 and the current options available to a user through the menu structure.

Multifunction device 100 can, and typically does include application components 126 that provide a runtime environment in which software applications or components can run or execute. Those skilled in the art will recognize that there are many different types of available runtime environments. A runtime environment facilitates the extensibility of multifunction device 100 by allowing various interfaces to be defined that, in turn, allow the application components 126 to interact with the multifunction device.

General reference is made herein to multifunction and/or data and media reproduction devices, such as multifunction device 100. Although specific examples may refer to one or more multifunction devices having particular functionalities, such examples are not meant to limit the scope of the claims or the description, but are meant to provide a specific understanding of the described implementations. Furthermore, It is to be appreciated that the described components are exemplary, and are not intended to limit application of the claimed subject matter to multifunction and reproduction devices that include only these components. Accordingly, other devices having components different from and/or in addition to those described herein can be used in implementing the described techniques and systems.

#### **Exemplary Computer Architecture**

Fig. 2 illustrates various components of an exemplary computing device 200 that can be utilized to implement the inventive techniques described herein. Computer 200 includes one or more processors 202, interfaces 204 for inputting and outputting data, and user input devices 206. Processor(s) 202 process various instructions to control the operation of computer 200, while

interfaces 204 provide a mechanism for computer 200 to communicate with other electronic and computing devices, such as multifunction device 100 (Fig. 1). User input devices 206 include a keyboard, mouse, pointing device, and/or other mechanisms for interacting with, and inputting information to computer 5 200.

Computer 200 also includes a memory 208 (such as ROM and/or RAM), a disk drive 210, a floppy disk drive 212, and a CD-ROM drive 214. Memory 208, disk drive 210, floppy disk drive 212, and CD-ROM drive 214 provide data storage mechanisms for computer 200. Although not shown, a system bus 10 typically connects the various components within the computing device 200.

Computer 200 also includes application components 216 and can include an integrated display device 218, such as for a portable laptop computer, personal digital assistant (PDA), and similar computing devices. Application components 216 provide a runtime environment in which software 15 applications or components can run or execute on processor(s) 202.

#### **Exemplary Image Scanning System**

Fig. 3 illustrates components of an exemplary image scanning system 300 in which a multifunction device 302 has a communication link with computing device 304 (Fig. 2) via a data communication network 306. 20 Multifunction device 302 can include one or more of the components of exemplary multifunction device 100 (Fig. 1), and computing device 304 can include one or more of the components of exemplary computing device 200 (Fig. 2), to include a display 308.

The data communication network 306 can be any type of network, such 25 as a local area network (LAN) or a wide area network (WAN), using any type of network topology and any network communication protocol. Although only the two devices are shown communicatively linked via network 306, a typical

network can have any number of devices connected to it, either directly or indirectly via another network system. The Internet is an example of multiple connected network systems each having multiple devices. Multifunction device 302 and computing device 304 can also have modems and/or network 5 cards that facilitate network communication and data transfer via data communication network 306.

Multifunction device 302 includes a print unit 310, a scanning unit 312, a memory 314, and one or more processors 316. Each of these components are described above with respect to the exemplary multifunction device 100 10 (Fig. 1). Multifunction device 302 also includes an automatic document feeder (ADF) 318, a media routing assembly 320, and an application component 322. Automatic document feeder 318 accepts multiple image media 324 and automatically feeds the image media into multifunction device 302 for scanning. Image media includes any print media, photographs, graphics, and 15 the like that can be scanned with scanning unit 312.

The media routing assembly 320 takes up an image or print media 324 and routes it through multifunction device 302 for scanning. This physical path of the image or print media through the multifunction device is typically referred to as the “print path” or “print medium path”. When image media 324 20 is routed within multifunction device 302 by the media routing assembly, the image media 324 passes within a proximity of scanning unit 312 which scans an image on the image media. Application component 322 executes on processor(s) 316 and receives image data corresponding to a scanned image from scanning unit 312. Alternatively, or in addition to application component 25 322 receiving image data corresponding to a scanned image, an application component in computing device 304 receives the image data from scanning unit 312 via the data communication link 306.

It should be appreciated that multifunction device 302 in this example is an ADF multifunction device. That is, an image recognition component of scanning unit 312 is fixed within multifunction device 302 and the image media 322 passes the recognition component when scanning an image. This is 5 functionally different from a flatbed scanner that positions an image media on a glass surface, for example, and then drives the image recognition component to scan an image on the image media. It should also be recognized that a flatbed scanner can also incorporate an automatic document feeder for the purpose of automatically feeding image media into place for scanning. However, a flatbed 10 scanner having an automatic document feeder still drives an image recognition component to scan an image.

#### **Exemplary Image Scanning System User Interface**

Fig. 4 illustrates an image scanning system user interface 400 which can be displayed on a computing device display, such as display 308 integrated 15 with computing device 304 (Fig. 3). User interface 400 has a viewing region 402 to display a scanned image preview 404.

An imaging device, such as multifunction device 300, performs an initial scan of an image to generate image data corresponding to the image. A scanning application component, such as application component 322 in 20 multifunction device 302, or application component 216 in computing device 200, creates the scanned image preview 404 from the image data. Fig. 4 illustrates an example scanned image preview 404 of an image having a photo region 406, a text region 408, and a lineart or graphics region 410.

User interface 400 includes multiple selection controls to initiate 25 scanning an image, processing and/or editing the image, and saving a final electronic form of the scanned image. The user interface selection controls include a destination selection control 412, an image region selection control

414, an image region definition control 416, a final-scan selection control 418, and a resolution selection control 420.

The destination selection control 412 is selected before initiating a scan of an image to choose a destination for a final scan of the image. A scanned image destination can include a printing device, to include the multifunction device utilized to scan the image, a faxing device, a data storage component, such as a memory component in a computing device or in the multifunction device, a third-party application such as an email program, and the like.

A destination for a final scan of an image, and more specifically the destination for the corresponding image data, can be an image data type or a text data type. For example, an image data type can be a bit map image of a photograph, graphic, or even text. A text data type is text data that has been processed with an optical character recognition component to generate the text data from a bit map image of text. A final scanned image is processed to have a resolution that corresponds to an image destination selection.

The image region selection control 414 is selectable to choose a region of the scanned image preview 404 to retain for a final-scan of the image data to generate a final scanned image. This is commonly referred to as “cropping” a preview scan. For example, Fig. 4 illustrates that photo region 406 is selected as the image region of the scanned image preview 404 to retain for a final scan.

When the region definition control 416 is selected, the regions of the scanned image preview 404 are each identified in the viewing region 402. Each of the photo region 406, text region 408, and lineart region 410 are identified with a border to indicate the boundaries of each region, as defined by the software application component. By further selecting an individual region, the classification or definition of the particular region can be changed. For example, text region 408 may be initially defined by the software application

component as drawing information when detecting the large capitalized first letter of the paragraph. Text region 408 can be redefined as text by selecting the image region definition control 416.

The final-scan selection control 418 (e.g., the “Send” selectable control 5 on user interface 400) initiates a final-scan of the image data corresponding to the image region selected to be retained, and generates a final scanned image that is routed according to an image destination selection choice. A final-scan of the image data is a virtual scan of the image performed by the scanning application component.

10 With an ADF multifunction device, or ADF imaging device, the image media is routed past the recognition component of a scanning unit when scanning an image. As a result, the image media is no longer positioned for the second, final-scan after the initial pre-view scan, as it typically would be in a flatbed scanner. It should be appreciated that the inventive techniques and 15 systems described herein are not only applicable to an ADF imaging device, but also to a flatbed scanner. A scanning application component for a flatbed scanner can also emulate a final-scan of image data, rather than driving an image recognition component to again scan the image to generate a final scanned image.

20 The scanning application component interpolates the image data to improve and/or optimize the resolution of the image region selected to be retained when virtually generating a final-scan of the image. The sharpness of a printed image depends on the resolution which refers to the number of dots within a measurable area, and is expressed in terms of the number of dots on a 25 horizontal axis and on a vertical axis, typically within one inch. The sharpness of a scanned image also depends on the resolution which refers to the number of pixels per inch (PPI).

The scanning application component evaluates the image data and estimates for new pixel data to be added between existing pixels by taking an average of the known pixel values at neighboring points to where the new pixel data is to be added (i.e., interpolates). The existing pixel data is generated 5 during the initial preview scan from the original image. However to create new pixel data for a final scanned image, non existing data has to be created and added between existing pixels.

A new pixel value can be derived from an average of the surrounding pixel values, or more complex algorithms can be implemented to expand and 10 include many more surrounding pixel values to calculate a new value for just one new pixel. More complex resolution interpolation algorithms go a step further and try to detect detail patterns that occur near to where a new pixel is to be added so as to further and more accurately adjust a new averaged value for new pixel data.

15 A common resolution PPI value for an initial preview-scan is seventy-five (75)ppi which takes less time to generate the image data than it would for a higher resolution scan. For a final image scan, such as for photos and graphics, a higher resolution of one-hundred fifty (150)ppi is considered optimal, and for text that will be processed for optical character recognition (OCR), 20 three-hundred (300)ppi is considered to be optimal. These PPI values are described as “optimal” with respect to the resolution detection capability of the human eye. For the most part, a human eye cannot detect a difference between one-hundred fifty (150)ppi and three-hundred (300)ppi. For an enlarged photo, or for other applications, “optimal” may require a higher resolution PPI.

25 For the image scanning system described herein, the preview-scan resolution value has a default setting of one-hundred fifty (150)ppi to accommodate photos and graphics which reduces processing time and

increases resolution quality when interpolating to generate a final scanned image having a resolution of three-hundred (300)ppi. It would take more processing time to interpolate from a resolution of seventy-five (75)ppi to three-hundred (300)ppi, and depending upon the complexity of the  
5 interpolation algorithm, the resolution quality will be better when starting with a preview scan having a resolution of one-hundred fifty (150)ppi rather than seventy-five (75)ppi.

Variable resolution scanning is implemented when a user changes from the default scanning resolution of one-hundred fifty (150)ppi for image data  
10 types, or three-hundred (300)ppi for a text data type, by selecting the resolution selection control 420 (e.g., the “Settings...” selectable control on user interface 400). A software or firmware component of a scanning application determines destination resolution for scan data corresponding to the data type associated with a destination selection, and determines a scan resolution based on the  
15 destination resolution. The resolution determinations are based on the following variable resolution mapping table.

| User Resolution Selection (ppi) | Scan Resolution Values (ppi) |
|---------------------------------|------------------------------|
| 149 ppi or less                 | 100 ppi                      |
| 199 ppi or less                 | 150 ppi                      |
| 299 ppi or less                 | 200 ppi                      |
| 300 ppi or greater              | 300 ppi                      |

#### Variable Resolution Mapping

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The variable resolution mapping table indicates if a user selects a destination resolution of two-hundred fifty (250)ppi, then the scanning

application or component determines a scan resolution for scan data to be two-hundred (200)ppi, for example. After the scan data is generated with a scan resolution of two-hundred (200)ppi, the scanning application or component interpolates the scan data to generate the user selected scan data destination 5 resolution of two-hundred fifty (250)ppi.

It should be appreciated that the variable resolution mapping table indicates exemplary scan resolution values only, and that any number of scan resolution values in any number of increments can be implemented. The scan resolution values described in this example are chosen to optimize processing 10 time when scanning an image. Additional time savings are realized when a scan resolution value that is less than a user selected resolution value is utilized when scanning an image. It should also be appreciated that improved resolution quality can be realized when a scan resolution value that is greater than a user selected resolution value is utilized when scanning an image.

15 **Methods for Variable Resolution Scanning**

Fig. 5 illustrates a method for variable resolution scanning. The order in which the method is described is not intended to be construed as a limitation. Furthermore, the method can be implemented in any suitable hardware, software, firmware, or combination thereof.

20 At block 500, a destination for scan data is selected. At block 502, a scan resolution for the scan data corresponding to a data type associated with the destination is determined. Determining the scan resolution includes determining a 150 pixel per inch scan resolution corresponding to an image data type, or alternatively, determining a 300 pixel per inch scan resolution 25 corresponding to a text data type. At block 504, the scan data is generated with the determined scan resolution.

Fig. 6 illustrates a method for variable resolution scanning. The order in which the method is described is not intended to be construed as a limitation. Furthermore, the method can be implemented in any suitable hardware, software, firmware, or combination thereof.

5 At block 600, a destination resolution for scan data is selected. At block 602, a scan resolution is determined that is different than the destination resolution. Determining the scan resolution can include determining a scan resolution that is less than the destination resolution, determining a scan resolution that is greater than the destination resolution, or determining a scan 10 resolution based on a variable resolution mapping having scan resolution values corresponding to selected destination resolution values.

At block 604, the scan data is generated with the determined scan resolution. Generating the scan data can include generating the scan data with a 300 pixel per inch (ppi) scan resolution for any selected destination resolution 15 of 300 ppi or greater. Generating the scan data can also include interpolating the scan data to generate the scan data with the destination resolution, interpolating the scan data to generate the scan data with an improved resolution, and/or interpolating the scan data to generate the scan data with an optimal resolution for a scan data type.

20 **Conclusion**

An imaging system determines the best scan resolution for scanning an image based on either a destination data type for the scanned image, or on a user selected scan resolution value. The imaging system determines the best scan resolution for a user selected scan resolution value based on variable 25 resolution mapping that considers both processing time and resolution quality when scanning the image.

Although the invention has been described in language specific to structural features and/or methodological steps, it is to be understood that the invention defined in the appended claims is not necessarily limited to the specific features or steps described. Rather, the specific features and steps are  
5 disclosed as preferred forms of implementing the claimed invention.